Comparison of the survival between coronary artery bypass graft surgery versus percutaneous coronary intervention in patients with poor left ventricular function (ejection fraction <30%): a propensity-matched analysis

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OBJECTIVES

Existing evidence comparing the outcomes of coronary artery bypass graft (CABG) surgery versus percutaneous coronary intervention (PCI) in patients with poor left ventricular function (LVF) is sparse and flawed. This is largely due to patients with poor LVF being underrepresented in major research trials and the outdated nature of some studies that do not consider drug-eluting stent PCI.

METHODS

Following strict inclusion criteria, 717 patients who underwent revascularization by CABG or PCI between 2002 and 2015 were enrolled. All patients had poor LVF (defined by ejection fraction <30%). By employing a propensity score analysis, 134 suitable matches (67 CABG and 67 PCI) were identified. Several outcomes were evaluated, in the matched population, using data extracted from national registry databases.

RESULTS

CABG patients required a longer length of hospital stay post-revascularization compared to PCI in the propensity-matched population, 7 days (lower–upper quartile; 6–12) and 2 days (lower–upper quartile; 1–6), respectively (Mood's median test, $P = 0.001$). Stratified Cox-regression proportional-hazards analysis of the propensity-matched population found that PCI patients experienced a higher adjusted 8-year mortality rate (hazard ratio 3.291, 95% confidence interval 1.776–6.101; $P < 0.001$). This trend was consistent amongst urgent cases of revascularization: patients with 3 or more vessels with coronary artery disease and patients where complete revascularization was achieved. Although sub-analyses found no difference between survival distributions of on-pump versus off-pump CABG (log-rank $P = 0.726$), both modes of CABG were superior to PCI (stratified log-rank $P = 0.002$).

CONCLUSIONS

Despite a longer length of hospital stay, patients with impaired LVF requiring intervention for coronary artery disease experienced a greater post-procedural survival benefit if they received CABG compared to PCI. We have demonstrated this at 30 days, 90 days, 1 year,

3 years, 5 years and 8 years following revascularization. At present, CABG remains a superior revascularization modality to PCI in patients with poor LVF.

INTRODUCTION

In recent decades, the rate of death from coronary artery disease (CAD) has been crippled by the advent of 2 efficacious and widely available treatments: Coronary artery bypass graft (CABG) surgery and percutaneous coronary intervention (PCI) [1]. In the absence of conclusive evidence from randomized controlled trials (RCTs), the 2 revascularization strategies have naturally been the subject of a contentious debate to determine which modality is superior in patients with poor left ventricular function (LVF).

The weak evidence base is reflected in current guidelines. The most recent 2014 European Society of Cardiology and European Association for Cardio-Thoracic Surgery (ESC/EACTS) guidelines summarize the recommended approach for revascularization in patients with poor LVF [2]. CABG is a class I recommendation, supported by level B and C standard of evidence. This recommendation stems from the results of the STICH trial where Velazquez *et al.* [3] found that patients who received CABG with medical therapy had significantly lower rates of death, from cardiovascular causes, compared to lone medical therapy. The success of CABG in heart failure has been emulated in a number of studies [4–6]. By contrast, there is a paucity of information regarding the role of PCI in patients with poor LVF. The ESC/EACTS 2014 guidelines state that ‘PCI may be considered …’ under the guise of a class IIb recommendation with level C evidence. Of the evidence that does exist, poor LVF is generally correlated with higher post-PCI mortality [7–9]. Furthermore, the guidelines do not mention any study that directly compares PCI with CABG in patients with poor LVF. This is disappointing and reiterates the need for further investigation into this topic.

Under current clinical practice, patients with poor LVF may not be receiving the best treatment. Consequently, they may be at higher risk of post-procedural complications, including mortality. This study aims to be the first clinical quality assessment in the UK to compare and evaluate the outcomes of PCI and CABG in patients with poor LVF. By employing a propensity score matching technique, we aim to minimize the bias that would otherwise undermine the value of such a retrospective study.

METHODS

Patient selection

Patients were selected from the British Cardiovascular Intervention Society (BCIS) and Society for Cardiothoracic Surgery (SCTS) registries. Validated patient data were collected with the Centricity Carddas (GE Healthcare, Chicago, IL, USA) and Cardiac PATS (Dendrite Clinical Systems Ltd, Henley-on-Thames, UK) and submitted to the BCIS and SCTS, respectively. The data were entered by the primary operator in the database. Completeness and accuracy of the data were validated in-house by the data manager before submission to the registries. For the purpose of this study, the data were then extracted by the data manager, who is responsible for submission. All patients who received CABG or PCI at the Bristol Royal Infirmary (BRI) between April 2002 and April 2015 and had poor LVF were included. Poor LVF was defined as a left ventricular ejection fraction (LVEF) of 30% or less and was based on the pre-operative transthoracic echocardiogram. These patients are discussed at our Heart Team multi-disciplinary weekly meetings to achieve a consensus whether to proceed with CABG or PCI. Magnetic resonance imaging to assess myocardial viability is performed before proceeding with any intervention. We excluded redo CABG procedures (i.e. CABG in patients who had prior CABG operations) and CABG procedures that were performed in conjunction with valve or major aortic surgery in the same operation. We excluded any emergency procedures (procedure performed without further delay; only elective and urgent procedures, during the same admission, were included), patients requiring primary PCI for ST elevation myocardial infarction (MI), haemodynamically unstable patients and patients in cardiogenic shock.

Propensity score matching

Seventeen independent variables (Table 1), describing various characteristics of the patient and the presenting lesion(s), were appropriately chosen and incorporated into a logistic regression model in order to generate a propensity score for each patient [10]. The propensity score, ranging from 0 to 1, describes a patient’s likelihood of receiving CABG (1), relative to PCI (0). To avoid large standardized differences, caliper widths defined as 0.1 of the standard deviation of the logit of the propensity score were employed to achieve more identical pairs. A nearest neighbour, without replacement, matching protocol was employed to match CABG patients with PCI patients. Frequencies of the 17 independent variables are presented in Table 1. Standardized difference of means was calculated for both continuous and categorical variables in order to ensure that the frequency of a variable was equally balanced between the

CABG and PCI arms of the matched population. We refitted the propensity score model with interaction terms in order to reduce the potential bias as much as possible where imbalance was found.

Table 1:

Frequencies of patient and lesion characteristics in the original and propensity-matched population

Variables	Original population			Propensity-matched population		
	PCI ($n = 219$)	**CABG ($n = 498$)**	**Standardized difference**	**PCI ($n = 67$)**	**CABG ($n = 67$)**	**Standardized difference**
Age (years)						
Mean (SD)	72.1 (11.04)	65.2 (12.93)	0.557	70.7 (11.21)	70.8 (9.48)	0.102
Median	74.0	68.0		74.0	73.5	
Height (cm)						
Mean (SD)	171.1 (9.08)	171.5 (9.05)	0.044	171.9 (9.65)	171.4 (7.90)	0.054
Weight (kg)						
Mean (SD)	80.1 (15.04)	82.3 (15.52)	0.143	84.8 (13.96)	81.4 (14.51)	0.233
BMI (kg/m^2)						
Mean (SD)	27.3 (4.64)	24.2 (10.90)	0.328	28.7 (4.76)	27.7 (4.62)	0.213
Gender (%)						

Variables	Original population			Propensity-matched population		
	PCI (*n* = 219)	CABG (*n* = 498)	Standardized difference	PCI (*n* = 67)	CABG (*n* = 67)	Standardized difference
Male	180 (82.2)	428 (85.9)	0.105	58 (86.6)	59 (88.1)	0.045
Female	39 (17.8)	70 (14.1)		9 (13.4)	8 (11.9)	
Smoking status (%)						
Never smoked	46 (21.0)	109 (21.9)	0.388	13 (19.4)	15 (22.4)	0.043
Ex-smoker	93 (42.5)	294 (59.0)		37 (55.2)	31 (46.3)	
Current smoker	58 (26.5)	95 (19.1)		17 (25.4)	21 (31.3)	
Diabetic (%)	66 (30.1)	164 (32.9)	0.060	21 (31.3)	20 (29.9)	0.032
Hypertension (%)	169 (77.2)	360 (72.3)	0.012	54 (80.6)	56 (83.6)	0.078
Neurological disease (%)[a]	14 (6.4)	58 (11.6)	0.174	6 (9.0)	6 (9.0)	0.000
Peripheral vascular disease (%)	28 (12.8)	78 (15.7)	0.082	11 (16.4)	9 (13.4)	0.084
Renal disease (%)[b]	16 (7.3)	12 (2.4)	0.255	4 (6.0)	3 (4.5)	0.067
Previous MI (%)	122 (55.7)	417 (83.7)	0.679	51 (76.1)	53 (79.1)	0.072

Variables	Original population			Propensity-matched population		
	PCI ($n = 219$)	**CABG ($n = 498$)**	**Standardized difference**	**PCI ($n = 67$)**	**CABG ($n = 67$)**	**Standardized difference**
Previous PCI (%)	53 (24.2)	34 (6.8)	0.550	12 (17.9)	13 (19.4)	0.038
Procedure urgency (%)						
Elective	62 (28.3)	178 (35.7)	0.155	22 (32.8)	19 (28.4)	0.097
Urgent	156 (71.2)	320 (64.3)		45 (67.2)	48 (71.6)	
Extent of CAD (%)[c]						
Single vessel	55 (25.1)	14 (2.8)	0.954	8 (11.9)	5 (7.5)	0.112
Double vessel	74 (33.8)	104 (20.9)		19 (28.4)	20 (29.9)	
Triple vessel	89 (40.6)	380 (76.3)		40 (59.7)	42 (62.7)	
LMS disease (%)[d]	38 (17.4)	147 (29.5)	0.279	20 (29.9)	23 (34.4)	0.096
Complete revascularization (%)[e]	124 (56.6)	425 (85.3)	0.713	48 (71.6)	48 (71.6)	0.000

a

History of neurological disease = if patient has suffered 1 or more cerebrovascular event i.e. transient ischaemic attack or stroke.

b

History of renal disease = if the patient’s pre-intervention renal function was abnormal i.e. plasma creatinine >200 µmol/l.

c
Extent of CAD = number of coronary arteries with ≥50% diameter stenosis.

d
LMS disease = LMS coronary artery with ≥50% diameter stenosis.

e
Complete revascularization = complete revascularization was achieved if: (i) (for CABG) anastomoses distal to lesion(s) were made in all arteries with CAD; (ii) (for PCI) if intervention, by angioplasty or stent, was successfully achieved in all arteries with CAD.

BMI: body mass index; CABG: coronary artery bypass graft; CAD: coronary artery disease; LMS: left main stem; MI: myocardial infarction; PCI: percutaneous coronary intervention; SD: standard deviation.

Statistical analyses and outcomes

Using the data from the BCIS and SCTS registries, we observed 2 short-term outcomes: Life status of the patient at discharge and length of hospital stay following revascularization. The former is compared between the PCI and CABG groups by the Pearson's χ^2 test. The latter is assessed by the Mood's median test to compare medians in the propensity-matched population. The principal, long-term outcome observed was all-cause mortality, measured at specific time points after the procedure was performed (30 days, 90 days, 1 year, 3 years, 5 years, and 8 years). These data were extracted from the BCIS and SCTS registries and supplemented by BRI databases. Date of final follow-up was 9 April 2018 at which point 0 patients were lost to follow-up. An 8-year survival analysis was performed using the Kaplan–Meier estimator model on the propensity-matched population. All Kaplan–Meier survival distributions were compared using the Mantel–Cox log-rank test stratified on the matched pairs to account for the matched nature of the data. Multivariable Cox proportional-hazards regression model, also stratified on the matched pairs, was subsequently applied to the matched population to identify any independent predictor of mortality. Covariates were included via a stepwise regression using a probability for stepwise entry of 0.05. Proportional-hazards assumption of the Cox regression model was tested graphically by means of log-minus-log plots of variables included in the regression model. We also explored differences in 8-year survival distributions between the on-pump and off-pump CABG procedures. Sub-analyses were conducted in order to determine whether the survival trends were consistent amongst subgroups. These subgroups include (i) procedure urgency, (ii) left main stem (LMS) disease, (iii) extent of CAD and (iv) completeness of revascularization. All statistics presented in this study were produced using IBM SPSS Statistics 24 (IBM Corporation, Armonk, NY, USA). All statistics reported apply to the propensity-matched population unless otherwise stated.

RESULTS

Our final dataset consisted of 717 patients, of whom 219 underwent PCI and 498 underwent CABG. Propensity score matching identified 134 suitable matches: 67 CABG and 67 PCI. Standardized differences and distribution of propensity scores showed extreme incomparability between the 2 treatment groups in the pre-matched population. Pre- and post-matched plots of the propensity score distributions are presented to show comparability of groups after matching (Fig. 1A and B).

Figure 1:

Mirror histogram showing distribution of propensity scores in (**A**) the pre-matched population and (**B**) the post-matched population. CABG: coronary artery bypass graft; PCI: percutaneous coronary intervention.

The median length of follow-up was 5 years, and maximum length of follow-up was 15 years. Within the matched population, 58 deaths occurred during the 8-year follow-up period (37 PCI, 21 CABG). Of the PCI procedures, 71.6% used drug-eluting stent (DES). The remainder of PCI involved bare metal stents or balloon angioplasty only. Of the 67 CABG patients, 47.8% and 49.2% underwent the on- and off-pump procedures, respectively. The nature of the procedure is unknown for the remaining 3.0%. Extent of CAD and LMS disease was defined by the number of vessels, or LMS, with ≥50% diameter stenosis. Extent of CAD was divided into 3 categories: 9.7%, 29.1% and 61.2% of patients had single, double or 3 or more vessels with CAD, respectively (Table 1). Of the matched population, 32.1% presented with LMS disease: 20 PCI and 23 CABG. Completeness of revascularization was achieved in a majority of patients, 71.6% for PCI and 71.6% for CABG.

Short-term outcomes

The Mood’s median test found that CABG patients had a longer length of hospital stay compared to PCI patients, 7 days (lower–upper quartile; 6–12) and 2 days (lower–upper quartile; 1–6), respectively ($P = 0.001$) (Fig. 2). In-hospital mortality was 10.4% for PCI and 4.5% for CABG patients. The Pearson's χ^2 test found this difference insignificant ($P = 0.189$).

Figure 2:

Length of hospital stay following revascularization by CABG or PCI. CABG: coronary artery bypass graft; PCI: percutaneous coronary intervention.

Long-term outcomes

The 8-year cumulative survival rate was $33.5 \pm 8.0\%$ and $66.9 \pm 6.0\%$ for PCI and CABG, respectively. The 30-day, 90-day, 1-year, 3-year and 5-year cumulative survival rates were also calculated (Table 2). The difference in survival distributions was consistent throughout the 8-year follow-up period (stratified log-rank $P < 0.001$) (Fig. 3A).

Table 2:

Kaplan–Meier survival table: PCI versus CABG

Treatment	Follow-up interval post-revascularization	Number alive at beginning of interval	Number of cumulative deaths	Cumulative survival % (± SE)
PCI	0 days	67	2	97.0 (2.1)
	30 days	60	7	89.6 (3.7)
	90 days	59	8	88.1 (4.0)
	1 year	53	14	79.1 (5.0)
	3 years	43	24	64.2 (5.9)
	5 years	22	33	48.0 (6.4)
	8 years	6	37	33.5 (8.0)
CABG	0 days	67	0	100.0 (0.0)
	30 days	65	2	97.0 (2.1)

Treatment	Follow-up interval post-revascularization	Number alive at beginning of interval	Number of cumulative deaths	Cumulative survival % (± SE)
	90 days	63	4	94.0 (2.9)
	1 year	60	7	89.6 (3.7)
	3 years	54	13	80.6 (4.8)
	5 years	49	15	77.5 (5.1)
	8 years	36	21	66.9 (6.0)

ABG: coronary artery bypass graft; PCI: percutaneous coronary intervention; SE: standard error.

Figure 3:

Eight-year cumulative survival of patients with poor left ventricular function: (**A**) PCI versus CABG and (**B**) PCI versus off-pump CABG versus on-pump CABG. CABG: coronary artery bypass graft; PCI: percutaneous coronary intervention.

Prior to multivariable regression analysis, the 8-year unadjusted hazard rate for PCI was 2.6 times higher than CABG [hazard ratio (HR) 2.603, 95% confidence interval (CI) 1.500–4.515; $P = 0.001$]. All variables listed in Table 1, except weight and height, were included in the stratified Cox regression model (Table 3). The adjusted HR described a higher 8-year mortality rate in the PCI group than in the CABG group (HR 3.291, 95% CI 1.776–6.101; $P < 0.001$). Poor preprocedural renal function (creatinine >200 µmol/l), hypertension and previous MI were identified as significant independent predictors of 8-year mortality ($P < 0.001$, $P = 0.002$, $P = 0.012$, respectively). Age and procedural urgency appeared to predict 8-year mortality although the results were not significant ($P = 0.059$, $P = 0.071$).

Table 3:

Stratified Cox proportional-hazards regression predictors of 8-year mortality: PCI versus CABG

Variable	Hazard ratio	95% confidence interval	*P*-value
Unadjusted			
Treatment (PCI)	2.603	1.500–4.515	0.001
Adjusted[a]			
Treatment (PCI)	3.291	1.776–6.101	<0.001
Age (years)	1.029	0.999–1.061	0.059
BMI (kg/m^2)	1.018	0.938–1.104	0.673
Female	1.500	0.682–3.297	0.313
Diabetes	1.604	0.804–3.202	0.180
Absence of hypertension	0.128	0.035–0.460	0.002
Absence of neurological disease	0.804	0.295–2.192	0.671
Absence of peripheral vascular disease	0.670	0.339–1.324	0.249
Absence of renal disease	0.104	0.036–0.302	<0.001
Previous MI	2.614	1.235–5.533	0.012
Previous PCI	0.829	0.379–1.807	0.635
Procedural urgency	0.555	0.288–1.067	0.078
Extent of CAD (single versus multi-vessel)	0.557	0.179–1.737	0.314
Absence of left main stem disease	0.881	0.472–1.645	0.691
Incomplete revascularization	1.488	0.802–2.761	0.207

a

All variables listed in Table 1, except weight and height, were included in the Cox regression model.

BMI: body mass index; CABG: coronary artery bypass graft; CAD: coronary artery disease; MI: myocardial infarction; PCI: percutaneous coronary intervention.

The Kaplan–Meier survival analysis of the on-pump versus off-pump CABG found no significant difference between survival distributions (log-rank $P = 0.726$). However, both modes of CABG were superior to PCI as summarized in Table 4 and demonstrated in Fig. 3B (stratified log-rank $P = 0.002$) (Table 4) (Fig. 3B). In elective cases, there was no significant difference in survival function between patients who received PCI or CABG ($P = 0.310$). The same analysis in urgent cases found that patients who receive PCI had 3 times the hazard of dying compared to CABG patients (HR 3.121, 95% CI 1.644–5.924; $P = 0.001$). Sub-analyses found no difference in the 8-year mortality rates of CABG and PCI amongst subjects presenting with single-vessel CAD. The 8-year mortality rate in the PCI group was almost thrice as large as CABG in patients who presented with triple-vessel CAD (HR 2.596, 95% CI 1.355–4.974; $P = 0.004$). In patients without LMS disease, there was a higher 8-year mortality rate amongst the PCI group (HR 2.880, 95% CI 1.436–5778; $P = 0.003$). Although this trend seemed to extend to patients with LMS disease, there was no significant difference between the survival distribution of PCI and CABG patients ($P = 0.081$). When complete revascularization was achieved, the CABG group experienced a lower 8-year mortality rate than patients who underwent PCI (HR 4.279, 95% CI 2.090–8.764; $P < 0.001$). No difference in 8-year mortality rate was observed for procedures with incomplete revascularization.

Table 4:

Kaplan–Meier survival table: PCI versus off-pump CABG versus on-pump CABG

Treatment	Follow-up interval post-revascularization	Number alive at beginning of interval	Number of cumulative deaths	Cumulative survival % (±SE)
PCI	0 days	67	2	97.0 (2.1)
	30 days	60	7	89.6 (3.7)
	90 days	59	8	88.1 (4.0)
	1 year	53	14	79.1 (5.0)
	3 years	43	24	64.2 (5.9)

Treatment	Follow-up interval post-revascularization	Number alive at beginning of interval	Number of cumulative deaths	Cumulative survival % (±SE)
	5 years	22	33	48.0 (6.4)
	8 years	6	37	33.5 (8.0)
Off-pump CABG	0 days	33	0	100.0 (0.0)
	30 days	32	1	97.0 (3.0)
	90 days	31	2	93.9 (4.2)
	1 year	29	4	87.9 (5.7)
	3 years	27	6	81.8 (6.7)
	5 years	26	7	78.8 (7.1)
	8 years	22	11	66.7 (8.2)
On-pump CABG	0 days	32	0	100.0 (0.0)
	30 days	31	1	96.9 (3.1)
	90 days	30	2	93.8 (4.3)
	1 year	29	3	90.6 (5.2)
	3 years	26	6	81.3 (6.9)
	5 years	25	7	78.1 (7.3)
	8 years	14	9	68.9 (8.9)

CABG: coronary artery bypass graft; PCI: percutaneous coronary intervention; SE: standard error.

DISCUSSION

Best practice is defined by conclusive and reliable evidence. However, in the field of revascularization, reliable evidence does not exist for patients with poor LVF as these patients are categorically underrepresented in major studies. This is demonstrated by the FREEDOM trial. Their sub-analyses found no significant difference between the outcomes of PCI and CABG amongst patients with poor LVF. This must be interpreted with caution as only 3.3% of PCI patients and 1.7% CABG patients in the trial had poor LVF [11]. Similar critiques found that only 2% and 21% of the cohorts enrolled in the SYNTAX and AWESOME trials had poor LVF, respectively [12]. Furthermore, the majority of studies that investigate poor LVF in revascularization are outdated as they were conducted before DES was introduced in interventional cardiology [13, 14]. Thus, the conclusions drawn from these studies are less applicable to modern medicine. Until an up-to-date RCT is conducted, this study aims to provide the next best level of evidence with an exclusive interest in patients with poor LVF.

In our study, we showed that patients with poor LVF who underwent CABG had a lower 8-year mortality rate compared to patients who underwent PCI. This trend was consistent amongst several subgroups, including high-risk patients with triple-vessel CAD and urgent cases of revascularization. The study of Bangalore *et al.* [15] compared CABG versus PCI in the context of poor LVF using a propensity-analysis approach. They found no significant difference in gross mortality rates or within subgroups. Based on our study, it is not possible to delineate cardiac or non-cardiac related mortality rate between the 2 groups. Furthermore, MI, stroke and hospitalization for heart failure, especially in patients with poor LVF, were important outcomes that might lead to death. Bangalore *et al.* extended their investigation and evaluated several of these secondary outcomes. They found that patients who underwent PCI were twice as likely to suffer from MI following revascularization [16]. Incidence of MI directly correlates with an increased risk of death. Following this, it is not surprising that PCI patients have an increased risk of readmission, and in the majority of cases they require repeat revascularization [15, 16]. Taking primary and secondary outcomes from both papers into consideration, CABG remains a superior intervention for patients with poor LVF. Based on the SYNTAX II risk scoring system [17], a patient with 20% LVF scores 20.5 points higher if they receive PCI treatment instead of CABG treatment. Depending on the other variables, this can correlate with a 43.3% higher mortality. This reiterates the superiority of CABG to PCI in patients with poor LVF. It must be noted that LVF is just one aspect of a patient and by considering other factors, as the SYNTAX II model advocates, a clinician can deliver a more individualized level of care. Nevertheless, this scoring system showed that in the context of poor LVF, CABG yields a stronger survival function compared to PCI.

The superiority of CABG over PCI can be explained by the dual function of CABG. In addition to providing revascularization, CABG improves LVF post-operatively. The average ejection fraction has been observed to increase from 25% to 31% as soon as 30 days following the operation [18]. This phenomenon was assessed more recently in both modalities. Revascularization by CABG and PCI increased LVEF by 15% and 5% after 12 months, respectively [19]. Although PCI has the capacity to restore LVF, the magnitude of its effect is significantly lower [20]. With improved LVEF, patients will benefit from higher physical fitness levels and they are less likely to suffer the complications of heart failure. To reap these benefits, clinicians should implement viability testing in patients with poor LVF. Viability testing assesses the quality of the myocardial tissue and whether it is amenable to improved LVEF [12, 14]. Thus, patients with poor LVF and viable tissue would benefit from CABG to prevent further ischaemic damage and restore ventricular function.

We found that CABG patients with poor LVF tend to require longer periods of recovery time in hospital following revascularization compared to PCI. This is not surprising as the operation is invasive, high-risk and demanding even in the simplest of cases. In contrast, major cardiology centres can sometimes perform PCI as day cases. Longer length of stay in hospital directly translates into more resources and costs consumed per CABG patient. In the ASCERT trial, CABG costs $10 670 and $8145 more than PCI per patient during the period of hospitalization (including the operation) and follow-up period, respectively [21]. However, when the analysis is extrapolated over a patient’s lifetime, CABG becomes substantially more economically attractive. The incremental cost-effectiveness ratio of CABG to PCI for patients with heart failure is $31 038/quality-adjusted life year (QALY) gained [22]. Interventions with an incremental cost-effectiveness ratio <$50 000/QALY gained are deemed favourable. This is primarily attributed to the fact that PCI patients experience higher rates of MI, readmission and repeat revascularization following the index revascularization—all of which incur further costs to the healthcare institution. Additionally, 9 out of 10 papers in a systematic review report that CABG patients have a higher quality of life 1 year after revascularization compared to PCI patients [23]. In the context of a patient’s lifetime, performing CABG in patients with poor LVF is justifiable as the initial costs are offset by the long-term benefits experienced by the patient and the healthcare system.

The technology used in PCI is rapidly evolving. Bare-metal stents have become obsolete, and second-generation DESs have proven dominance over first-generation DESs. Patient groups with second-generation DES unarguably enjoy lower rates of stent restenosis, stent thrombosis, repeat revascularization and death [6]. Other technologies such as GPIIa/IIIb inhibitors and peri-operative intra-aortic balloon pumps support PCI and offer significantly lower mortality rates compared to unsupported PCI [24]. They improve the ability and scope of PCI, allowing interventional cardiologists to treat high-risk patients, including those with poor LVF [25].

Limitations

The overall quality of evidence presented is limited by the inherent biases that observational studies are susceptible to. One of them is the failure to control for pretreatment confounders and operator experience. Although in the original population the number of patients treated with CABG was larger than those treated with PCI, propensity matching was employed to address the issue of patients undergoing PCI due to surgical ineligibility. The matching process resulted in far fewer matches; i.e. 67 PCI cases were matched out of a potential 219. This may be due to the adherence of guidelines in the decision-making by the multi-disciplinary team. Additionally, different data collection methods were employed by the 2 registries, which may have resulted in inadequate reporting of patient and procedure characteristics. This could have resulted in less identical matches after propensity scoring and increases the influence of confounding bias. Although this study is based on 2 well-reputed national registries, they do not collect data on rehospitalization, rate of stroke, MI, repeat revascularization and life quality indices, and hence it is not possible to obtain these data based on our study. However, a well-designed RCT on this topic would indeed be able to address this issue.

CONCLUSIONS

Despite longer periods of hospitalization, this propensity-matched analysis has demonstrated that the CABG group has a significantly lower 8-year mortality rate compared to the PCI group in patients with poor LVF. In this context, we conclude that CABG is a superior revascularization intervention to the current standard of PCI. We believe that although guidelines are available to offer some advice on this, they are insufficient and based on weak evidence. This study will significantly contribute to the body of literature supporting the role of CABG in patients with poor LVF. However, in this modern era of interventional cardiology we are witnessing a diminishing difference in mortality rate between PCI and CABG. Above all, this topic merits the attention of an RCT in order to provide an irrefutable, truly unbiased answer that will enable clinicians to deliver the highest standard of healthcare to patients with poor LVEF.

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